

PHYSICS LOGIC  
Physical Sciences for the Logic Stage

Cool Chemistry  
Hands-on, inquiry based with literature connections

UNIT  
SAMPLE

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SAMPLE

## FREQUENTLY ASKED QUESTIONS

### **WHAT DOES THIS ENTAIL?:**

My goal in writing this curriculum is to provide a hands-on science curriculum that will challenge your middle-level child and instill a love of science. I have included hands-on activities every week, readings, as well as long-term projects. All of the activities described have been field tested in the public school setting with students in 4th-6th grade. The lessons are written with homeschooling families in mind but can also be adapted to a co-op or classroom setting.

*Life Logic* (Life Sciences for the Logic Stage) will be comprised of three units or volumes (Botany, Zoology and Ecology). *Earth Logic* (Earth Sciences for the Logic Stage) will also be comprised of three units (Our Dynamic Earth, Weather & Climate, and Astronomy). *Physics Logic* will be comprised of three units as well (Electricity & Magnetism, Simple Machines & Laws of Motion, and Chemistry). Each unit is designed to stand alone or can be taught in conjunction with any other unit.

### **WHAT IS THE SCHEDULE?:**

I've planned a minimum of two activities each week. The day of the week in which you teach the lesson is entirely up to you. Feel free to modify the plan to better suit your style of teaching and the interest of your children. Reading assignments are frequently incorporated to prepare students for the hands-on activity, providing them with some background knowledge and thereby ensuring greater success.

### **WHAT BOOKS AND MATERIALS WILL I NEED?:**

A variety of non-fiction books which may be found in your own library or borrowed from the public library are suggested for many of the lessons. However, background information is provided for each lesson so that you may feel comfortable presenting without further study. I also provide web links to online videos and lessons that will enhance the material presented here.

Necessary lab materials are outlined within each lesson. Most all materials are readily available. Suggestions on where to obtain more unusual items (if any) are detailed within the lesson.

### **HOW INVOLVED ARE THE EXPERIMENTS?:**

Experiments are laid out in a step-by-step manner and tie into what is being studied. The experiments provide the students with hands-on experience with inquiry based science. At the middle-level (Logic Stage), I strongly feel that students should develop the skills of writing out the steps of the scientific method in a science notebook or journal.

I have therefore not created a student sheet to accompany the majority of these experiments. Please encourage your middle-level student(s) to journal their questions, observations, and experimental results in a science notebook (a composition book, spiral bound notebook, loose leaf in a 3-ring binder, etc.).

However, considering that many students may yet be unfamiliar with this process, a scientific method or inquiry template is included in the *Appendix*.

**WHAT ARE LONG-TERM PROJECTS?:**

Long-term projects are activities that will take more than one standard class session to complete. Depending upon the student's level of interest and their approach, most long-term projects take a 2-4 weeks to complete. The description of the project can be found in the *Appendix*.

**WHERE DO I GET THE HANDOUTS AND ACTIVITY SHEETS?:**

*Handouts* are provided as a springboard for discussion. Essentially, the handouts are meant to be used together much like a classroom teacher would put them on the overhead projector for the entire class. *Activity Sheets* are also provided and have been created for the child to fill out as a part of the hands-on portion of the lesson. Both can be found following the lesson plan to which it corresponds.

**ARE VOCABULARY WORDS PROVIDED?:**

Yes. Within each lesson, vocabulary words are provided. There is also a vocabulary list for each unit provided in the *Appendix*. The vocabulary words that are pertinent to each lesson are defined in the lesson plan. You may choose to use these as spelling words or dictionary work (practice looking up the word and writing the definition).

**ANYTHING ELSE?:**

Many of the lessons include *Extension Activity* suggestions as well as a list of *Suggested Readings* and / or related *Web Links*. These are designed to give you ideas for additional activities and for additional reading on the topic presented.

A unit test is also included in the *Appendix* for those who wish to assess what has been learned.

If you find that you and your child(ren) desire more, than I highly recommend incorporating nature study into your curriculum. I have created an outline of suggested topics and related readings from the *Handbook of Nature Study* by Anna Comstock. It is available free on my website.

As the author and publisher of this curriculum I encourage you to contact me with any questions or problems that you might have concerning any of the publications in the *Science Logic* series. I hope you enjoy *Physics Logic*!

Unit Outline - Chemistry		
Week 1	Matter All Around	Temperature & Change of State
Week 2	Sublimation & Deposition	Properties & Changes Mixtures & Compounds
Week 3	Temperature Effects on Solubility	Colloids & Suspensions
Week 4	What is Density?	Chromatography
Week 5	Periodic Table of Elements	Atomic Structure
Week 6	Models of Compounds	Covalent vs. Ionic Compounds
Week 7	Polymers	Chemical Reactions
Week 8	Exothermic Reactions	Endothermic Reactions
Week 9	Forming Precipitates	Conservation of Matter
Week 10	Acids & Bases	Mystery Powders

SAMPLE

LESSON PLANS  
&  
STUDENT HANDOUTS

SAMPLE

# Temperature & Change of State

## Subject Areas

Chemistry, Mathematics  
(Graphing)

## Overview

Students will examine how much increase in temperature is necessary in order for ice to change into water and then for water to change into steam.

## Objectives

Students will:

1. be able to distinguish similarities and differences of matter.
2. be able to recognize the properties of each state of matter.

## Materials

Ice

Chemical or candy thermometer

Beaker or saucepan

Bunsen burner, Ring stand and Mesh screen or Stove-top burner

Safety goggles

Timer

Record sheet

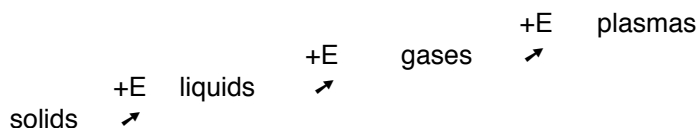
Pencil

## Duration

60 minutes

## Background Information

There are five main states of matter. Solids, liquids, gases, plasmas, and Bose-Einstein condensates are all different states of matter. Each of these states is also known as a phase. Elements and compounds can move from one phase to another phase when special physical forces are present. Things only move from one phase to another by physical means. If energy is added (like increasing the temperature or increasing pressure) or if energy is taken away (like freezing something or decreasing pressure) you have created a physical change.



One compound or element can move from phase to phase, but still be the same substance. You can see water **vapor** over a boiling pot of water. That vapor (or gas) can **condense** and become a drop of water. If you put that drop in the freezer, it would become a solid. No matter what phase it was in, it was always water. It always had the same chemical properties. On the other hand, a chemical change would change the way the water acted, eventually making it not water, but something completely new.

The three physical states of matter are properties that help distinguish one substance from another. Of the three most commonly known phases, solids are the densest state of matter. The molecules in solids are more tightly packed than either liquids or gases.

Plasmas have a neutral charge. Even though electrons are stripped away from the atoms, the positively charged nuclei remain. The positive charges cancel out the negative charges.

## Procedure

1. Place 4-6 ice cubes in a small beaker or saucepan.
2. Hold a thermometer directly onto an ice cube for 1 minute to record a beginning temperature for the ice.
3. Record this starting temperature in the chart on the next page.
4. Without removing the thermometer from the beaker, place the beaker on the wire mesh on the ring stand, or on a stove-top burner.
5. Put on your goggles and light the Bunsen burner or turn on the stove-top burner. (An adult should do this.)
6. Without removing the thermometer, measure the temperature every 30 seconds as the ice melts, the water heats, and then begins to boil.
7. Record all temperatures on the *Temperature & Change of State Data Sheet* provided.
8. Graph your temperature data on the *Temperature & Change of State Data Sheet* provided, and label on the graph where melting and evaporating first occur.

## Conclusions

Complete the worksheet, *Temperature & Change of State Experimental Questions*

## Answers to Experimental Questions

1. Answers will vary, but should be in the range of -2 to +10 degrees.
2. Answers will vary, but should be in the range of +85 to +110 degrees.
3. Answers should come from first flat area of the line graph.
4. The temperatures should remain fairly constant for both situations.
5. Heat added to the beaker does not cause a temperature increase.
6. Freezing would release heat into the surroundings.
7. When the water freezes on the plants, the process releases tiny amounts of heat that keep the plants from freezing.
8. Heat from your hand melts the ice cube.

# Temperature & Change of State Data Sheet

TIME TEMPERATURE

Start	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	
5.5	
6.0	
6.5	

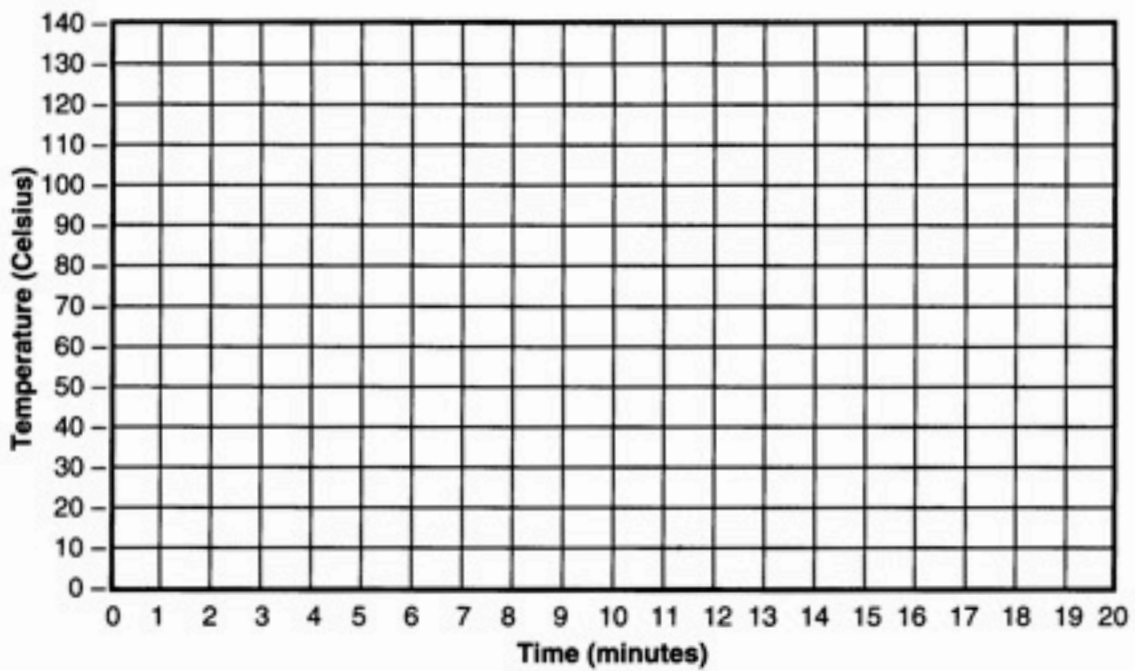
TIME TEMPERATURE

7.0	
7.5	
8.0	
8.5	
9.0	
9.5	
10.0	
10.5	
11.0	
11.5	
12.0	
12.5	
13.0	
13.5	

TIME TEMPERATURE

14.0	
14.5	
15.0	
15.5	
16.0	
16.5	
17.0	
17.5	
18.0	
18.5	
19.0	
19.5	
20.0	

TEMPERATURE VERSUS TIME



## Temperature & Change of State Experimental Questions

1. According to your data, at what temperature is water in the form of ice?
2. According to your data, at what temperature does water boil?
3. Look at the graph of your data. What is the temperature range where the ice had just completed melting?
4. Look at the graph of your data. What happens to the temperature as the solution:
  - completes melting?
  - is boiling continuously?
5. What evidence might you have that a 'change of state' requires the use of the heat energy that would otherwise have caused the temperature to increase?
6. If the process of melting absorbs heat energy from the surroundings, then what would the process of freezing do?
7. Why do citrus farmers spray water on their crops the evening before the temperature is predicted to drop below freezing?
8. The heat that your hand loses to an ice cube is used to do what?

# Colloids & Suspensions

## SAMPLE LESSON Not Shown in Entirety

Subject Areas  
Chemistry

### Overview

Students will explore numerous examples of colloids, foams and mixtures.

### Objectives

Students will learn that there are three types of mixtures: solutions, suspensions and colloids and will be able to recognize examples of each.

### Materials

Can of soda pop of choice  
Salt  
Baking soda  
Water  
Vinegar  
Hydrogen peroxide  
Acetone  
Yeast  
Two 5 oz. wax cups  
Cake pan w/ 2" sides  
Empty plastic soda bottle or a 100mL graduated cylinder  
Liquid soap (Dawn dish soap works best)  
Coffee straw or stir stick  
Packing peanuts (5 of each color: green-polystyrene; light yellow or cream-cornstarch)  
Styrofoam cup  
Food coloring (optional)

### Background Information

A **colloid** is defined as any two chemicals or chemical compounds that are associated with one another but not connected to each other to form a new compound. Styrofoam that is used to make insulated plastic cups is one example. When the styrene, a kind of plastic, is heated and then injected into a mold it is mixed with air. The air is dispersed or trapped in the spaces between the styrene molecules, forming a plastic foam. This trapped air is what allows polystyrene to insulate so well.

In the styrofoam cup example, this type of colloid is a gas dispersed in a solid. A colloid can also be a solid dispersed in a liquid (milk, i.e., curds and whey), a gas dispersed in a liquid (soda pop), a liquid dispersed in a liquid, or any combination of solids, liquids, and gases so long as they do not combine chemically.

*What happens when you go to the refrigerator, grab and soda and quickly pour it into a glass? The soda produces all those bubbles at the top of the glass that we call foam. The gas (carbon dioxide) is trapped or dispersed in the liquid (the soda), which means means you have created a colloid. Some chemicals produce a lot of gas when they are mixed. If they happen to be mixed in a solution and some of the gas gets trapped by the liquid, they produce a foam.*

What happens when you add a little bit of soap to water in a small jar, seal it with the lid, and shake? Bubble form because the air in the jar is trapped in the water and soap mixture. However, because you shook the test tube and there was no chemical reaction this is called **mechanical foam**. Mechanical foam is likely very familiar - swooshing about in a bubble

# Atomic Structure

## SAMPLE LESSON

Not Shown in Entirety

### Subject Areas

Chemistry

### Overview

Students will create their own paper model of an atom.

### Objectives

Students will be able to interpret the element information on the Periodic Table of Elements.

### Materials

#### *Periodic Table of Elements*

3 colors of construction paper or several thumbtacks of three different colors

Square of corrugated cardboard (if using thumbtacks rather than paper)

White paper (if using colored paper)

Glue stick (if using colored paper)

Protractor

Pencil

### Duration

60 minutes

### Background Information

Our world is made of matter. We define matter as anything that has weight (mass) and takes up space (volume). Matter is made up of tiny particles called atoms. An atom is the smallest particle of a pure substance which has all the characteristics or properties of that substance.

Atoms are made of tiny particles called **protons**, **neutrons**, and **electrons**. Protons are positively charged particles in the center of the atom (nucleus). They are very heavy. The number of protons in an atom's nucleus is that atom's **atomic number**.

Neutrons resemble protons in size and weight, but have no electrical charge (neutral charge). Protons and neutrons together make up the **nucleus** or center of the atom. The number of protons plus the number of neutrons is that atom's **atomic weight**.

Electrons are negatively charged particles which rotate around rapidly in orbital clouds or rings that surround the nucleus. They have almost no weight so are not considered in determining the weight of an atom. Atoms join together by sharing electrons. Most of the atom is nothing but space. The distance from the nucleus to the first electron is 10,000 times the diameter of the nucleus.

The simplest substances contain just one type of atom and are called **elements**. There are 92 elements that occur naturally on this planet, but they are usually found combined with other elements. The millions of different kinds of substances we have are different combinations of these 90 elements.

# Acids & Bases

## Subject Areas

Chemistry

## Overview

Students will test a variety of household liquids to discover first-hand the differences between acids and bases.

## Objectives

Students will:

1. Develop operational definitions of acids and bases.
2. Use chemical indicators to identify whether a solution is acidic, basic or neutral.
3. Recognize the relationship between the  $[H^+]$  and  $[OH^-]$  in an aqueous system.

## Materials

10 - 12 Common household liquids

Ice Cube Tray

pH test papers

Small dish (for discarding used strips)

Paper towels (for spills)

## Duration

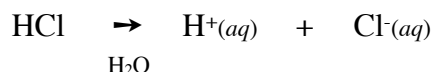
60 minutes

## Background Information

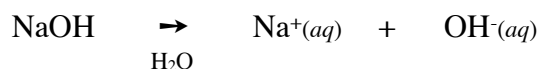
While there are many slightly different definitions of acids and bases, in this lesson the fundamentals of acid / base chemistry will be introduced.

In the 17th century, Robert Boyle (an Irish scientist) first labeled substances as either **acids** or **bases**. He described acids as substances that taste sour, are corrosive to metal and change litmus (a dye extracted from lichens) red. Bases, he stated, feel slippery and change litmus blue.

In the late 1800s, Svante Arrhenius (a Swedish scientist) proposed that water can dissolve many compounds by separating them into their individual ions. Arrhenius suggested that acids are compounds that contain hydrogen and can dissolve in water to release hydrogen ions into solution. For example, hydrochloric acid (HCl) dissolves in water as follows:



Arrhenius defined bases as substances that dissolve in water to release hydroxide ions ( $\text{OH}^-$ ) into solution. For example, sodium hydroxide (NaOH) dissolves in water as follows:



This definition also explains how acids and bases counteract each other, a process we call **neutralization**. Acids release  $\text{H}^+$  into solution and bases release  $\text{OH}^-$ . If we were to mix an acid and base together, the  $\text{H}^+$  ion would combine with the  $\text{OH}^-$  ion to make the molecule  $\text{H}_2\text{O}$ , or plain water:



The neutralization reaction of an acid with a base will always produce water and a **salt**.

*Note: Generally, a salt is any ionic compound except those that contain hydroxide or hydrogen ions. Specifically, a salt is any compound other than water formed by the reaction of an acid and a base. In common usage, the term salt, or table salt, refers to the ionic compound sodium chloride, NaCl.*

Both acids and bases are related to the concentration of hydrogen ions present. Acids increase the concentration of hydrogen ions, while bases decrease the concentration of hydrogen ions by accepting them. The acidity or basicity of something can be thereby measured by the concentration of hydrogen ions. The pH scale was invented by a Danish scientist, Søren Sørensen, in 1909.

In summary...

### ***Acids***

- contain hydrogen (H<sup>+</sup>) ions
- on scale numbers 1 - 6
- taste sour
- present in many foods
- are corrosive to metals
- change litmus or cabbage juice red
- the more H<sup>+</sup> ions, the stronger the acid, the lower the number on the pH scale
- become less acidic when bases are added

### ***Bases***

- contain hydroxide (OH<sup>-</sup>) ions
- on scale numbers 8 - 14
- taste bitter
- feels slippery
- present in many cleansers
- change litmus or cabbage juice blue
- the more OH<sup>-</sup> ions, the stronger the base, the higher the number on the pH scale
- become less basic when acids are added

## Procedure

1. Begin by making a table on notebook paper with the following column headings: *Name of Substance* / *pH Number* / *Acid or Base - The Result*.
2. In the *Name of Substance* column, make a list of a variety of liquids in your house that you will test.
3. Put a small amount of each test liquid into a section of the ice cube tray or other small container. Make a guess whether the substance is an acid or a base and record on your chart under the column *Acid or Base - My Guess*.
4. Test each substance by dipping the pH paper strip into the solution. The paper will change color. Match the test strip to the color guide on the package and record the number on your chart under the column *pH Number* and whether the substance is an acid or base under the

column *Acid or Base - The Result*. Acids will have a number between 1 and 6. Bases will have a number between 8 and 14.

5. Compare your results with the chart provided here. You may have tested different substances. The chart is simply a sample of some the substances you may or may not have tested. You may wish to use the internet or other reference material to look up the pH value if your test substance is not in the chart.
6. How do your results compare?

### Extension Activities

Here are a couple fun little online quizzes:

[http://www.chem4kids.com/extras/quiz\\_reactacidbase/index.html](http://www.chem4kids.com/extras/quiz_reactacidbase/index.html)

[http://www.quia.com/quiz/264206.html?AP\\_rand=874870949](http://www.quia.com/quiz/264206.html?AP_rand=874870949)